

Change of Land Use and Forest Resources on Miyako Island

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Introduction

Recently, the decline of forest resources has been widely discussed, especially in the case of tropical forests. However, the forest area of developed countries has generally been increasing. In Japan, the total area of forests was 251,800km² in 1975 and 252,600km² in 1989 (National Land Agency). In Japan as a whole, the ratio of forested to all land has remained almost constant at about 67%. However, this ratio is quite variable depending on the locality.

Japan consists of 6,852 islands, including the 4 main islands of Hokkaido, Honshu, Shikoku and Kyushu, as well as the Okinawa Main Island, Northern Territory (Habomai Islands, Shikotan Island, Kunashiri Island and Etorofu Island), and Takeshima. Among them, 334 islands are populated and are specified by island promotion laws, excluding the 4 main islands, Okinawa Main Island, Northern Territory and Takeshima. The total area of these 334 islands is 7,795km², representing 2.1% of the total area of Japan. The total forest area of these islands is 4,684ha, and the ratio of forested land is 60%. Because these islands are small, a change in land use tends to have an effect on the forest resources.

Miyako Island, the 4th largest island in Ryukyu Islands, was the research area of this study. This island has undergone a drastic change in land use practices. As a research area, Miyako Island has several distinctive characteristics: the climatic zone is sub-tropical, and this island is on the cruising course of typhoons; in addition, it is a part of the Ryukyu Islands (Okinawa Prefecture), which area was governed by the United States for 27 years until May 15, 1972. The ratio of forested land has clearly decreased since the island was returned to Japan. Although these are important factors affecting the change of the forest resources on this particular island, this study case is also thought to include several common characteristics of the forest resources of small populated Japanese islands. In this study, the change of forest resources and land use practices was analyzed statistically. The main factors that cause such a decreasing tendency of forest resources, agricultural activities and tourism are analyzed. In the last section, policy recommendations are presented.

Miyako Island is the largest of the Miyako Islands, which consist of 8 islands. Three small islands, Ikema Island (2.83km²), Ogami Island (0.27km²) and Kurima Island (2.84km²) are located near Miyako Island. The former 2 islands are a part of Hirara City, the main district of Miyako Island; the latter island is a part of Shimoji Town, one of the towns of Miyako Island. Since most statistics regarding this area also include those for these three small islands, it is not

possible to extract only those regarding Miyako Island. Thus, the data presented in this paper include data for these three islands in addition to Miyako Island, with a few notable exceptions. The Miyako Islands also include Irabu Island and Shimoji Island (Irabu Village), Tarama Island and Minna Island (Tarama Village). Some of the forest resource statistics presented in this paper are those for the entire island group.

Abstract of Miyako Island

Miyako Island (Hirara Port) is located 303km southwest of the Okinawa Main Island (Naha Port). The area of Miyako Island is 158.5km², and the length of its coastline is 117.5km (excluding the three small neighboring islands). The area is the 21st largest island area in Japan (including the Northern Territory and Okinawa Main-Island). This island is surrounded by coral reefs. Geographically, it is composed of limestone, and is flat tableland. The highest point on Miyako Island is 115m above sea level. As there are no mountains, rivers have not developed, and drinking water is supplied by underground water. Most of the coast is steep bluffs.

This area is in a sub-tropical climatic zone. The maximum average monthly temperature, recorded in July, 1990, was 33.2°C; the minimum, recorded in January, 1990, was 12.1°C. The annual precipitation was 1,965mm in 1990. This island is on the cruising course of typhoons, and the damage is considered in this study. During the period from 1973 to 1990, 67 typhoons passed within 300km of Miyako Island.

The population of Miyako Island has been decreasing: in 1950, 1960, 1970, 1980 and 1990, it was 70,818, 69,443, 58,667, 58,797 and 55,429, respectively. In 1990, the percentage of 0-14-year-olds, 15-64-year-olds, and 65-year-olds and over (and that for Japan as a whole) was 26.4% (18.2%), 58.9% (69.5%) and 14.7% (12.0%), respectively. The proportion of children and elderly people is low. Generally, young people frequently leave the island after graduating from school.

The output of primary, secondary and tertiary industry represents 24.9%, 26.8% and 48.3%, respectively, of the total output of Miyako Island. The main primary industry is production of sugar cane, and the main secondary industry is construction supported by public works. Agriculture and fisheries were formerly important economic sectors, but the economic importance of tourism is projected to exceed that of primary industries.

Forest Resources

1. Change of forest area

Miyako Island is divided into 4 municipalities. Table 1 shows the private and public forest area on a forest planning basis classified by municipal body. There is no national forest on Miyako Island. In 1993, the total forest land including treeless and other land was 2,681ha, having decreased by 2,137ha during the previous 20 years since 1973. Thus, 44.4% of the total forest land disappeared and was converted to other land use during the brief 20 years since Miyako Island was returned to Japan. The main purpose of this study was to clarify the causes

for the decline in forest land and to clarify the recent forest policy issues which have emerged as a result of this rapid decline. The total decrease was 290ha in the fiscal years 1973-1977, 1,531ha in the fiscal years 1978-1982, 284ha in the fiscal years 1983-1987, and 32ha in the fiscal years 1988-1993, and the decrease was most prominent during the fiscal years 1978-1982, when the annual rate of decrease was approximately 300ha.

Table 1. Forest land area (area of forest planning)

District	Year* ¹	Total	Wood land									Treeless land and others* ²
			Total		Artificial forest			Natural forest				
			Total	Conife-forest	Broad-leaved forest	Total	Conife-forest	Broad-leaved forest	Total	Conife-forest	Broad-leaved forest	
Hirara City	1973	1,852	1,586	170	1,416	406	170	236	1,180	0	1,180	266
	1978	1,973	1,174	175	999	577	170	407	597	5	592	799
	1983	1,320	845	197	648	425	174	251	421	23	398	476
	1988	1,210	778	215	563	434	195	239	344	20	324	432
	1993	1,201	772	214	558	431	194	237	341	20	321	429
Gusukube Town	1973	1,991	1,046	72	974	167	72	95	879	0	879	945
	1978	1,774	882	38	844	206	24	182	676	14	662	892
	1983	1,081	885	49	835	260	47	213	625	3	623	196
	1988	988	801	39	762	251	38	213	550	2	548	186
	1993	976	790	39	751	247	38	209	543	2	541	185
Shimoji Town	1973	402	244	13	231	48	13	35	196	0	196	158
	1978	409	214	16	198	54	14	40	160	2	158	196
	1983	339	234	26	208	66	17	49	168	9	159	105
	1988	285	206	24	182	61	17	44	145	7	138	78
	1993	274	197	24	173	60	17	43	137	7	130	76
Ueno Village	1973	573	307	71	236	126	71	55	181	0	181	266
	1978	372	177	6	171	70	6	64	107	0	107	195
	1983	257	162	4	159	45	2	43	118	2	115	95
	1988	230	152	4	148	43	3	40	109	1	108	79
	1993	230	152	4	148	43	3	40	109	1	108	79
Total	1973	4,818	3,183	326	2,857	747	326	421	2,436	0	2,436	1,635
	1978	4,528	2,447	235	2,212	907	214	693	1,540	21	1,519	2,082
	1983	2,997	2,126	276	1,850	796	240	556	1,332	37	1,295	872
	1988	2,713	1,937	282	1,655	789	253	536	1,148	30	1,118	775
	1993	2,681	1,911	281	1,630	781	252	529	1,130	30	1,100	769

Source: Okinawa Prefectural Government, Okinawa Prefecture Statistical Yearbook.

*1 As of April 1.

*2 Total of cut-over land, treeless land, land difficult to regenerate, and others.

Table 2 shows the ratio of forested to all land by year and municipal body. The overall percent of forested land decreased from 29.3% in 1973 to 16.3% in 1993, and the decline was observed in all municipalities, being especially prominent in Shimoji Town and Ueno Village,

where it was almost 10%. The local newspaper (*Miyako Shinpo*, January 1, 1994) has recently noted the decline in forested land and the importance of windbreak forests and tide water control forests in areas along the main course of typhoons.

Table 2. Ratio of forest to land*¹

Year* ²	(%)				
	Hirara City	Gusukube Town	Shimoji Town	Ueno Village	Total
1973	28.9	34.4	17.3	29.7	29.3
1978	30.8	30.6	17.6	19.3	27.5
1983	20.6	18.7	14.6	13.3	18.2
1988	18.9	17.1	12.3	11.9	16.5
1993	18.8	16.9	11.8	11.9	16.3

Source: Okinawa Prefectural Government, Okinawa Prefecture Statistical Yearbook.

* 1 Ratio = forest area ÷ land area(1988) × 100

* 2 As of April 1.

Forest resources on Miyako Island classified by tree species are shown in Table 3. As this forest resource table was calculated for use in establishing the regional forest plan, the planning period of which began on April 1, 1988, the forest resources as of 1987 are shown. The percent of artificial forests, 38.9%, is higher than that for the entire Ryukyu Island group, and is slightly lower than that for the whole of Japan. Needle-leaved forests represent 32.1% of the artificial forests, and the main species is *Pinus lutchuensis*. As is characteristic of this island, the artificial forests are mainly broad-leaved. The largest area is occupied by *Casuarina equisetifolia*, which represents 70.3% of all broad-leaved artificial forests. Rather than timber production, the main importance of this species is non-economic, such as a windbreak and in tide water control.

Table 3. Forest resources by tree species

Item	(ha, 1,000m ³)					
	Area			Quantity of growing stock		
	Total* ¹	Artificial forests	Natural forests	Total* ¹	Artificial forests	Natural forests
Total	2,029	789	1,239	107	56	50
Needle-leaved forests	Total	282	253	30	24	3
	<i>Pinus lutchuensis</i>	273	244	30	24	3
	<i>Podocarpus macrophyllum</i>	10	10	0	0	0
Broad-leaved forests	Total	1,746	536	1,210	82	47
	<i>Casuarina equisetifolia</i>	630	377	252	38	13
	<i>Calophyllum inophyllum</i>	57	57	0	1	0
	Others	1,060	102	957	42	8

Source: Okinawa Prefectural Government, Regional Forest Plan of Miyako and Yaeyama (planning period, from April 1, 1988 to March 31, 1998).

* 1 Subtotals do not accord with the total, because figures have been rounded off to the nearest whole number.

The total volume of growing stock on Miyako Island is 107,000m³, and the average volume per ha is only 52.7m³, which is lower than the average for the Ryukyu Islands, and lower still than that for the Japanese mainland. The average volume of growing stock in each regional planning area in the Ryukyu Islands is as follows: 98m³/ha in the northern part of the Okinawa Main Island; 66m³/ha in the central and southern part of the Okinawa Main Island, and 88m³/ha in the Miyako and Yaeyama Islands.

The forest areas are either coastline forests or inland forests. The coastline forests include mangrove forests, which have recently come to be viewed from a new environmental perspective. The Shimajiri community, located at the northern part of Miyako Island, has a unique mangrove forest of considerable.

2. Conversion of forest land

The area of private land classified by land category is shown in Table 4. Forests are included in the category of grassland in this table. The percent of farm land has been increasing, and was 76.3% in 1991. Miyako Island is flat, and most of its land, excluding the coastline and the limestone-wall, area can be developed as agricultural land. Together with the land area for building, the non-forest area is as much as 81.2%, and the expansion of agricultural land has therefore recently been halted.

Table 4. Area of private land in Miyako Island*¹

Year* ²	(ha)				
	Total	Farm land	Land for building	Grassland	Others
1973	13,559	9,122	445	3,964	28
1978	12,655	8,900	562	3,168	25
1983	12,309	9,355	554	2,305	95
1988	12,532	9,570	587	2,261	114
1991	12,523	9,552	611	2,170	191

Source: Okinawa Prefectural Government, Okinawa Prefecture Statistical Yearbook.

*1 Total of 4 municipal bodies. Including Ikema Island and Ogami Island.

*2 As of January 1.

According to the Census of Agriculture and Forestry in 1990, the total conversion area of forest land on Miyako Island during the period from fiscal year 1980 to fiscal year 1989 was 66ha. This included 8ha for buildings, 22ha for golf courses and leisure sites, 24ha for agriculture, and 12ha for public utilities. As the statistics for conversion of forest land are based on the regional forest planning area including all of the Miyako Islands and the Yaeyama Islands, specific data for this island alone are not available.

3. Protected forest

In Japan, 17 types of protected forest have been established by the current Forest Law (Note 1). As shown in Table 5, there are 5 types of protected forests on Miyako Island. Protected

forests represent 34.0% of the total area under the forest planning system of the Forest Law, including treeless land and others (see Footnote 2 in Table 1). This percentage is similar to that for Japan as a whole, 33%. As this research area is an island in the open sea, tide water control forest and windbreak forest are predominant, and the total for both types of protected forest is 84.8%. Under the forest protection system, duplicate designation is possible. In this area almost all recreational forests are also other types of protected forests.

Table 5. Protected forest in Miyako Island*¹

Type of protected forest	Area	Ratio* ²	(ha, %)
			Ratio* ³
Headwaters conservation forest	12	1.3	0.4
Windbreak forest	341	37.0	12.6
Tide water control forest	441	47.8	16.3
Drought disaster control forest	125	13.6	4.6
Recreation forest	126	13.7	4.6
Total* ⁴	922	113.3	34.0

Source: Okinawa Prefectural Government, Forestry in Okinawa (1990ed.).

*1 As of March 31, 1989.

*2 The ratio to the total area of protected forest.

*3 The ratio to the total area of forest planning, including treeless land.

*4 Subtotals do not accord with the total, because duplicate data are shown for forests designated as protected forests under two or more categories.

With regard to the geographical distribution characteristics of the protected forests, most of the coastline of the island is shown as forest land on the land use map. However, this coastline is steep bluffs, and the forest is not always readily subject to utilization. Generally, most of the coastline shown as forest on the land use map is not suitable for agricultural use, road construction or any of various other kinds of public works. Moreover, the average volume of these forests is small. The protected forests on the coastline are located mainly on the south side of the island. Ouno Forest, the largest and most unique forest area in Miyako Island, is now being prepared as a recreation forest. Recently, the public has become aware of the necessity of preserving protected forest, especially windbreak forest and headwater conservation forest.

4. Planting

On this island, cutting activities have not been conducted for the purpose of timber production. Almost all recent cutting activities have been associated with several developmental works, for example, farm construction, leisure site construction, and road construction. Accordingly, the forestry activity is limited to planting.

The main planting species are listed in Table 6. *Pinus lutchuensis* represented 58.2% of the total planting area during the fiscal years 1973-1991, after the Ryukyu Islands were returned to Japan. This is the main species found in man-made forests on Miyako Island, followed by *Casuarina equisetifolia* and *Calophyllum inophyllum*. The planting area classified by municipal bodies is 159.40ha for Hirara City, 123.62ha for Gusukube Town, 6.89ha for Shimoji Town, and

1.82ha for Ueno Village. During the period 1973-1981 the ratio of planting area to the total land area was 2.5% in Hirara City, 2.1% in Gusukube Town, 0.3% in Shimoji Town, and 0.1% in Ueno Village. The extremely small area of planting in the two municipal bodies located in southwest Miyako Island is noteworthy.

Table 6. Area of plantation

Species	(ha, %)	
	Area* ¹	Percentage
<i>Pinus lutchuensis</i>	169.88	58.2
<i>Casuarina equisetifolia</i>	71.72	24.6
<i>Calophyllum inophyllum</i>	35.70	12.2
<i>Podocarpus macrophyllus</i>	8.04	2.8
Others	6.39	2.2
Total	291.73	100.0

Source: Okinawa Prefectural Government.

*1 Total of fiscal year 1973-1991.

The planting history of *Pinus lutchuensis* on Miyako Island goes back to 1655. The local ruler Shirakawauji Keikon (1625-1702) planted *Pinus lutchuensis* for use as logs in ship- building. He understood the importance of *Pinus lutchuensis*, and he acquired seedlings from the Main Island of Okinawa. In the Ryukyu Islands, Saion (1682-1761) is known to have established a forestry policy, but Shirakawauji Keikon understood the importance of forest resources even earlier than Saion. Because there was no sizable forest on Miyako Island at that time, logs for ship and building construction were imported from the Yaeyama Islands. In this sense, the impact of the lack of forest resources was already an historical record even three hundred years ago.

During the reigns of Shirakawauji Keikon, Shirakawauji Keiji (1668-1744) and Shirakawauji Keituu (1691-1762), planting activities spread to the whole of Miyako Island. The many planting species included *Pinus lutchuensis*. Some of the trees that were planted at that time still stand on the island today. It was necessary to build ships for the trade between the Japanese mainland and the Ryukyu Islands and for the trade with China. In addition, it was also necessary to supply logs for use on the islands. Thus, the forest resource policy generally tended to be of importance. During World War II, most of the old forests were cut down for military purposes.

The total planting area per year after 1973 shows a progressive decrease, as already discussed. Immediately after the Ryukyu Islands were returned to Japan the annual planting area was over 30ha, but in 1990 and 1991 it was less than 1ha. The decline of the planting area from 1975 to 1976 is due to the rapid decrease of planting of *Casuarina equisetifolia*. This species has been extensively planted for windbreak forests throughout the entire Ryukyu Islands. Secondly, the planting area of *Pinus lutchuensis*, the main planting species of the Ryukyu Islands, also decreased, and the reforestation was discontinued in 1989. The common reason for

the decrease in *Pinus lutchuensis* reforestation throughout the entire Ryukyu Island group seems to be the lack of usage and the damage by forest insects, especially the Japanese pine sawyer (*Monochamus alternatus* Hope).

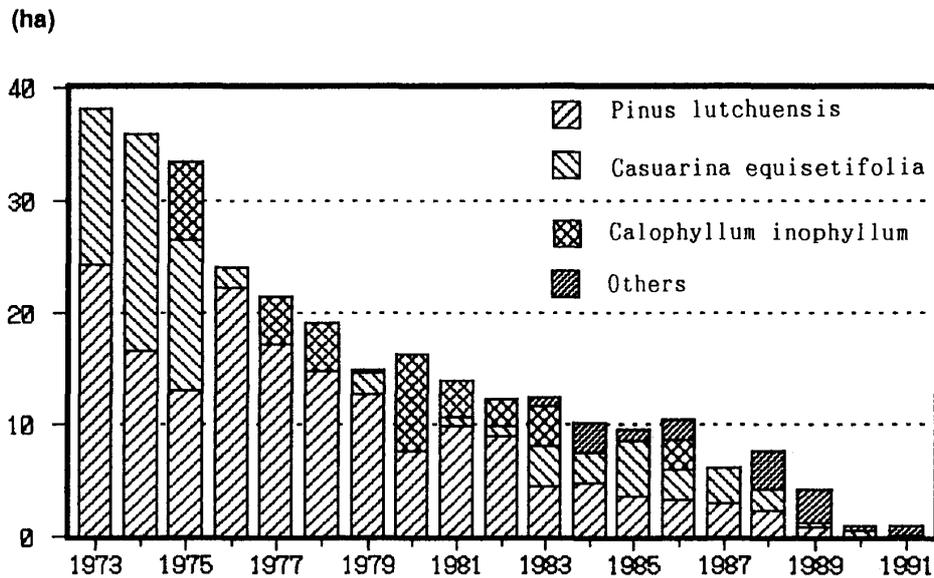


Fig. 1. Area of plantation (Miyako Island)

Source: Okinawa Prefectural Government.

Note: As of fiscal year.

On Miyako Island, damage due to the Japanese pine sawyer has not been observed, but that due to the pine caterpillar (*Dendrolimus spectabilis* Butler) is currently spreading in Shimoji Village, and the village office is attempting to control it. There is concern that the damage will expand to encroach on the Ouno Forest, the only large forest area on the island, or to foul the water supply (*Miyako Mainichi Newspaper*, April, 16, 1993).

5. Regional Forest Plan

Miyako Island is a part of the regional forest planning area of the Miyako Islands and the Yaeyama Islands. The total land area of this regional forest planning area covers 36% of that of Okinawa Prefecture. In the basic planning policy, the 4 municipalities of Miyako Island are all classified as land-conservation areas. The objective in such areas is the promotion of the disaster prevention function of forests.

The major aspects of the past and current regional forest plans for Miyako Island are listed on the left in Table 7. The standard final cutting age is shown in Note 2. Excluding the planning period 1978-1987, the annual planned cutting volume was approximately 400m³. Only broad-leaved forests were designated for cutting in the first and second forest plans, while mostly needle-leaved forests were designated in later plans. Although the *Pinus lutchuensis* has technically reached the final cutting stage in the forest plan, the growth is not always good, and recently there is almost no usage. Although the volume is very low, the cutting volume

designated for thinning in the regional forest plan has rapidly increased, although it is doubtful that thinning is actually practiced on Miyako Island.

Table 7. Regional forest plan*¹

Planning period* ²	Cutting (m ³)					Planting (ha)			
	Total	Needle-leaved forests	Broad-leaved forests	Final cutting	Thinning	Total	Expansion of man-made forest	Reforestation	Natural regeneration
1973-1982	4,300	0	4,300	4,300	0	140	140	0	0
1978-1987	8,000	0	8,000	8,000	0	265	260	5	0
1983-1992	4,330	3,110	1,220	4,254	76	290	270	10	10
1988-1997	4,100	3,700	400	3,900	200	144	119	25	0

Source: Okinawa Prefectural Government.

*1 Total cutting volume during the planning period.

*2 Fiscal year.

The abstract of the plantation plan is shown on the right in the table. The total planting area designated in the first plan was 140ha, and that in the second plan was almost two-fold. In the 4th plan, the area was decreased to the same level as that in the first plan. As shown in the previous table, the total planting area during the period 1973-1991 was 292ha, or 15.4ha annually, and is approximately equal to the area designated in the first and 4th regional forest plans. Thus, consideration of the overall data indicates that the planting plan has actually been carried until recently. However, as was discussed previously, the recent annual planting area is approximately 1ha, which is lower than the designated area (Note 3).

Almost all of the planting was categorized as expansion of a man-made forest. Thus, almost no planting area was designated as reforestation. Accordingly, there are almost no cutting activities due to forestry. Furthermore, natural regeneration systems have not been adopted for the silviculture systems on this island.

Resort Construction

1. Importance of tourism in the Ryukyu Islands

Tourism is an important economic sector on Miyako Island. Table 8 shows some statistical data related to the tourism industry. The estimated number of tourists entering Miyako Island was almost 159,000 in 1991, almost twice that in 1983, and a recent rapid increase is clear. The percentage of all persons who entered by airplane has increased to 97.6% in 1991, while that by ship has decreased.

From Miyako Airport, there is one daily direct flight to Tokyo and another to Osaka and this is an important factor in the tourist volume. The total flight time is 165 minutes and 135 minutes, respectively. The air routes between Miyako and Tokyo and Osaka were opened in

Table 8. Tourism statistics for Miyako Island

Year	Number of tourists* ¹ (a)	Consumption		(person, ¥, million ¥)	
		Estimated consumption per capita (b)	Total (a)×(b)	Accommodations* ²	
				Number* ³	Total capacity
1982	78,605	-	-	66	1,602
1983	79,156	41,520	3,287	67	1,651
1984	100,150	-	-	65	2,024
1985	119,980	41,520	4,982	63	2,020
1986	128,080	50,000	6,404	62	2,001
1987	129,660	50,000	6,483	61	1,972
1988	131,572	-	-	61	1,940
1989	142,750	-	-	63	1,960
1990	167,241	70,000	11,707	62	1,946
1991	158,794	70,000	11,116	65	2,002

Source: Okinawa Prefectural Government, Miyako Branch Office.

*1 Estimated number obtained by multiplying the total number of persons entering Miyako Island by air or ship by the estimated ratio of tourists to total visitors.

*2 As of December 31.

*3 Total for hotels, inns (Ryokan in Japanese), and tourist homes (Minshuku in Japanese).

July, 1989 and July, 1992, respectively, and there are also 7 flights each day from Naha, the main city of the Ryukyu Islands (flight time, 40 minutes). Naha International Airport is one of the most important airports in Japan, and there are direct flights between Naha and almost all of the main domestic airports. The marked improvement in air access has strongly contributed to the increase in the tourist volume in the area.

When the estimated average consumption per person is assumed to be ¥70,000, the total consumption by tourists is calculated to be 11 billion yen. The gross agricultural production in the fiscal year 1991 was 12.4 billion yen, and the economic importance of tourism is therefore comparable to that of agriculture. The total number of accommodations was 60-67 during this 10-year period, in 1991 included 5 hotels, 51 inns ("Ryokan" in Japanese), and 9 tourist homes ("Minshuku" in Japanese). The total number of rooms excluding those in tourist homes was 734, and the capacity was 2,002 persons per day. Miyako-jima Tokyu Resort Hotel, the largest hotel on Miyako Island, with a capacity of 298 persons (maximum capacity, 483), opened in 1984 in Shimoji Village. The Tokyu Hotel is among the largest tourist industries, together with railways, other hotels, and travel agencies.

The most famous event on Miyako Island is the triathlon games, which were started in 1985 to activate the regional economy. The number of participants had grown to over 1,000 in 1993 (*Miyako Mainichi Newspaper*, January 1, 1994). A training camp for a professional baseball team was established on the island in 1992. Miyako Island is now promoting a regional

development policy with the slogan "sports island." The sports event and the camp have greatly increased the public recognition of Miyako Island throughout Japan.

2. Recent resort facilities development on Miyako Island

Recently, several large resort facilities have opened or been planned on Miyako Island. Several new facilities were opened or began construction in 1993, and the *Miyako Mainichi Newspaper* (January 1, 1993) referred to the year as "the first year of the resort." The third Okinawa Development Plan (from 1992 to 2001) noted the development policy of Miyako Island as the long-term excursion marine resort sight-seeing area. There are presently 15 resort facilities in the planning stage on Miyako Island. Facilities that have newly opened or begun construction are described below. The main sources of the information in this section are two local newspapers, the *Miyako Mainichi Newspaper* and the *Miyako Shinpo*.

The environmental problems associated with the rapid construction have not gone unnoticed. For example, La-pisara Resort has encountered environmental opposition to alleged water pollution caused by its golf course.

1) German Culture Village (Doitsu-Bunka-Mura)

A part of this leisure park in Ueno Village opened on July 15, 1993. In 1873, the residents of Miyako Island rescued members of the crew of a Germany trading vessel in distress. Using this historical accident, the Ueno Village Office has been promoting construction of resort facilities designed to provide an atmosphere of cultural exchange, preparation of a long-term residence resort, and activation of the village. This park is planned for completion by fiscal year 1995. The main financial sources are the 2 types of subsidy from the national government, and the total cost of construction is projected to be 2.6 billion yen (*Miyako Mainichi Newspaper*, July 15, 1993). The location is now a beach (Hakuai Beach).

2) Miyako Island Hotel Resort Professional School

Construction of a professional school relating to hotels and resorts near Miyako-jima Tokyu Resort Hotel in Shimoji Village is being contemplated. The projected cost is 10.8 billion yen. Several resort hotels are scheduled for construction in the near future, but there is a shortage of recreational facility personnel, especially instructors of island marine sports (*Miyako Mainichi Newspaper*, January 1, 1994). It is notable that not only resort hotels but also this type of school have been planned on Miyako Island. Human resources development is also important for the growth of the local economy. However, since there are not many high school graduates on Miyako Island, the recruitment of students from other locales is an important managerial consideration.

3) Port Hirara Coastal Resort

Port Hirara, the main port of Miyako Island, is now under reconstruction as a coastal resort area. The construction, started in 1993, is anticipated to provide a marine leisure center on Miyako Island. The many planned facilities scheduled for completion in the first phase of construction by the fiscal year 1996 include marine leisure, marina, hotel, restaurant, and cottage facilities, as well as a 1,000-m long artificial beach. The total area of this resort area, which is

scheduled to be completed in 2000 (*Miyako Mainichi Newspaper*, January 12, 1993 and January 1, 1994), is approximately 35ha. It is the first full-scale facility for marine sports on Miyako Island. The third Okinawa Development Plan cites Port Hirara as the tourism center of the entire Miyako Island group and the goal of promotion of this resort project together with local city district development.

4) Takamatsu-Kaihatsu Resort

This resort facility is located in Gusukube Village, and the construction of a golf course and hotel is scheduled to begin soon. The total area of this resort is 116ha, the total investment cost is 63.4 billion yen, and all facilities are planned to be completed by 2000. The total number of employees is projected to be 600 (*Miyako Shinpo*, June 26, 1992 and *Miyako Mainichi Newspaper*, January 1, 1994).

3. Resort-related forest development

With the increasing importance of tourism on Miyako Island, the forest resources must also be viewed from a new perspective.

An example of a recreation forest in the making can be found in Gusukube Village. On November, 1993, Gusukube Village started development of a forest for recreation known as "Ikoi-no-mori." Several facilities for recreation, nature observation, trails for jogging, and outdoor research are scheduled for construction on the village property. The development area is approximately 30ha, and the projected total construction cost is over 300 million yen, subsidized by the Ministry of Home Affairs and the Forestry Agency (*Miyako Mainichi Newspaper*, October 8 and November 10, 1993). The Forestry Agency subsidy is provided by the Forestry Structural Improvement Project, one of the main projects under Forestry Law. Part of this forest park will be opened in the fiscal year 1995.

Discussion

The forest resources on Miyako Island have multiple uses, and play a variety of important roles. Windbreak forests, headwater conservation forests, and recreational forests are especially important, and these functions are related to each other, with the same forest having several functions at the same time. Although it has been argued that any forest generally has several functions, this point is particularly relevant to the forests on this island. Although these main functions cannot be clearly separated from each other, any attempt will be made to discuss them separately in the following discussion.

1. Windbreak forest

As we have seen, the main land use purpose for which the forests were converted is agriculture, especially sugar cane production. It is certainly profitable for land owners to expand their farms rather than retain existing forests. As an island is by nature generally a limited area, the ratio of the demand to the land supply is relatively high. In addition, Miyako Island is flat, and the whole island is suitable for agriculture. Thus, if this conversion is allowed to continue without control, almost all of the flat private land area will be converted to agricultural land.

The main factors which have contributed to the increased conversion to agricultural land until recently are the reliance of the local agricultural economy on mainly sugar cane production, the low monetary value of forest timber, and the subsidy system.

The 7 leading items of agricultural production on Miyako Island are sugar cane, leaf tobacco, vegetables, fruit trees, flowering plants, sericulture produce, and potatoes. The production of sugar cane (7,436 millions yen), leaf tobacco (1,503 millions yen) and vegetables (1,016 millions yen) accounts for 97.4% of the total value for these 7 crops. Sugar cane production is the most important crop in the island's agricultural economy, accounting for 72.8% of the total value. This pattern is almost the same as that of land use. Production of these 7 crops involves a total of 5,820ha of farm land, of which 4,887ha (84.0%) is for sugar cane production. Table 9 shows the annual sales of sugar cane for the Miyako Islands. Although the year-to-year change of production is high, the overall production has remained fairly constant during the past 10 years. In addition, the price of sugar cane has not increased. Accordingly, the total market is concluded to be sluggish. Thus, because the farmers would like to expand their production area as much as possible, forests are likely to be cut down.

Table 9. Sales of sugar cane

Year	Production	(1,000t, ¥/t, million ¥)	
		Price	Value
1980-81	235	20,820	4,885
1981-82	374	21,410	8,001
1982-83	311	21,450	6,678
1983-84	409	21,470	8,784
1984-85	398	21,470	8,554
1985-86	424	21,470	9,112
1986-87	348	21,470	7,479
1987-88	436	20,960	9,143
1988-89	321	20,540	6,600
1989-90	507	20,540	10,411
1990-91	315	20,540	6,464
1991-92	362	20,540	7,436
Average	370	21,057	7,795

Source: Okinawa Prefectural Government, Miyako Branch Office.

Note: Total for the Miyako Islands.

As agricultural income has not increased, some farmers have resorted to going off the island to work. A research survey conducted by the Miyako Employment Association (Miyako Koyou Kyokai) indicated that, during the research period from September to December in 1990, the total number of workers who left the island to work was 275, and that 59.3% of them were engaged in agriculture. Generally, a small farmer who grows mainly sugar cane is in difficult circumstances (*Miyako Shinpo*, March 6, 1991). Under the present economic conditions, few young people want to work in agriculture, and the majority are more interested in promoting

tourism. In this respect, young people are thought to be in favor of the development of resort facilities. As the expansion of farms will contribute both to the increase of income and to the improvement of productivity, improvement of agricultural land is one of the essential conditions in maintaining the interest of young people.

With regard to the low value of forest resources, almost all consumed forest products are now imported from other islands, mainly from Naha on the Main Island of Okinawa, due to the lack of forest resources producing lumber for construction. There are no longer any large mills or chip manufacturing facilities. The only exception is logs for woodworking. Only a few logs of *Pinus lutchuensis* and *Calophyllum inophyllum* are used as woodworking logs, and logs can also be obtained from various development work sites. With this exception, there is almost no usage of the island's own forest products. Thus, forest management and development has not been practiced on private land, and private forest owners are apt to regard their own forests as vacant land.

In the Japanese subsidy system, the subsidy of agriculture is generally liberal. In addition, the Okinawa Development Agency has been promoting several public works at premium subsidy rates. Government-managed land improvement enterprises have been introduced on Miyako Island, and the project period is from 1987 to 2000. The objective of this project is the breakaway from "agriculture with no water" to irrigation systems for 8,400ha of farm land. With the use of systems, the productivity of sugar cane is expected to increase, and new crops that thrive in the sub-tropical climatic zone can be introduced. It is estimated that the percentage of the total farm area devoted to sugar cane production will decrease from 81% to 60% after this project is completed.

Generally, regulations regarding the creation or the conservation of windbreak forests are included in agricultural improvement projects. However, windbreak forests are expected to disappear after several years, and the owner of the agricultural land will plant agricultural crops, in most cases sugar cane, in their place. To take a simple case, if the owner of a 1ha farm plants a 6m-wide windbreak forest surrounding the farm on the property, the actual farm area is decreased to 77.4%. Of course, the rate of decrease depends on the initial farm area; for example, if the farm area is 2ha, the actual farm area decreases to 83.7%. In addition, there is a possibility of poor yield within a certain width in the immediate vicinity of the windbreak forest (*Miyako Shinpo*, August 12, 1991). Together with the decrease in the available farm area, the total decrease may be as much as 20% or more for a farm of 1ha or 2ha. Most farmers can not afford to sacrifice this much of their available land.

On the other hand, the yield of sugar cane can be increased by 10% to 15% by a good windbreak forest. Almost every year, sugar cane farms are damaged by typhoons, and the yield is adversely affected. Thus, the Miyako branch office of the Okinawa Prefectural Government Agriculture Department is now advising farmers of the necessity of planting windbreak forest (*Miyako Shinpo*, March 30, 1991). As shown in the previous table, the total yield of sugar cane is unstable due to drought and typhoon. As water resources will be improved after the

introduction a large-scale underground dam system, the damage by typhoon will be focused on as the next most important agricultural problem (*Miyako Shinpo*, February 4, 1992). In this sense, there is increasing local opinion in favor of windbreak forests. Most farmers understand the necessity for windbreak forests, but this understanding does not extend to actual planting.

2. Headwater conservation forests

The stability of water resources is one of the common problems widely found in island communities. Of course, the relative degree of importance of water resources varies with the island, but the following three points are specific to the present situation on Miyako Island.

The first is the need for a stable water supply for agricultural land. As we have seen, farm improvement projects have expanded continuously until recently on Miyako Island. The main crop has been sugar cane, but the introduction of new crops has recently been promoted. The underground dam system is expected to supply water for the recently improved agricultural land. Traditionally, the agriculture on this island has depended on rainwater, and small water-supply wagons have been used for transport from the water resource to the farm. It is expected that the agricultural utilization of water from the underground dam will have positive agricultural effects, for example, increased income, labor saving, planned production, and introduction of new crops (*Miyako Mainichi Newspaper*, January 1, 1993).

Secondly, the future water demand is expected to be increased by the development of tourism. In 1992, the public water supply service on Miyako Island presented the long-term outlook for water demand-and-supply considering the 15 planned resorts. Of the increased daily water usage, 8,000m³ is attributed to the resort facilities and 5,000m³ to other local increase (*Miyako Shinpo*, February 25, 1992). The water supplier requires the development of new water resources, and in particular recommends the construction of an underground dam for financial reasons.

Finally, the prevention of water pollution is a concern on Miyako Island. The inhabitants are acutely aware that water resources are influenced by the resort development and the input of agricultural chemicals. There has been environmental opposition to the La-pisala Development Plan, which includes the construction of a golf course.

For these three reasons, the creation and maintenance of headwater conservation forest has been considered. Because the causative interactions are not clearly understood, the rationale for the forest creation is presented from the point of water conservation. For example, the Okinawa Prefectural Government is planning a headwater conservation forest improvement project on Irabu Island, one of the Miyako Islands, using a subsidy from the Ministry of Home Affairs of the Japanese Government (*Miyako Mainichi Newspaper*, September 29, 1993). The total budget is 227 million yen.

3. Recreational forest

Because tourism is becoming an increasingly important economic sector on Miyako Island, attention must be paid to recreational use in the development of resource policy. Windbreak forests, forest parks, and mangrove forests, all forest resources related to tourism.

The role of windbreak forests is not limited to the protection of agricultural land. Windbreak forests are a part of scenic beauty of island areas. Photo 1, of a representative scene in the Miyako Islands, shows the windbreak forest of a small farm. The tree species of this windbreak forest is *Garcinia subelliptica*. Such agricultural scenes are an important aspect of the promotion of tourism in



Photo 1. Windbreak forest

this area. Recently, several hotels with large capacity are under construction or in planning, and the municipal offices are attempted to change the period of resort stays to longer than one-day. Of course, the windbreak forest is also important for marine resorts as it provides cool shade along the beach.

Photo 2 shows the forest road of Ouno Forest, the only large forest area on the island, which is located in Hirara City. This forest is a valuable recreational area for both residents and visitors. In the recent final environmental assessment report for road construction, changing the route was recommended from the view point of forest conservation (Note 4). The management object of this forest should be recreational use.

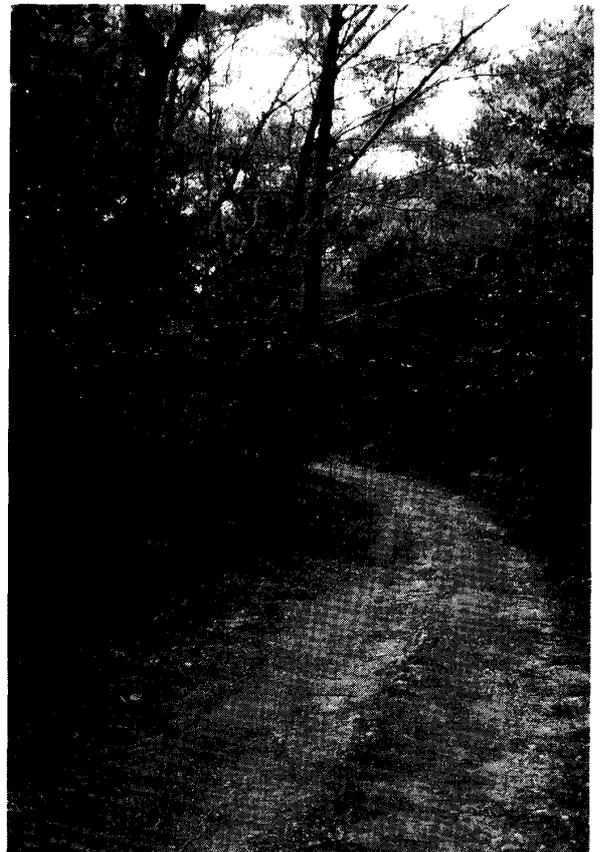


Photo 2. Ouno Forest

In the Ryukyu Islands, there are many traditional religious sites, known as "Utaki," which are usually covered by broad-leaved trees. Nakasone (1988, p.281) estimated that there were almost 800 such sites on Miyako Island, including very small ones. Tree cutting is strictly prohibited in these places, for religious reasons. Nakasone (1988, p.276) concluded that the conservation of these religious places carries with it the conservation of forest resources, resulting in the maintenance of timber resources and

headwater conservation. Some of these sites are now sight-seeing destinations which are described in traveller's guidebooks.

Mangrove forests occupy only a limited portion of Japan, and they are found only in Kagoshima and Okinawa Prefectures. Thus mangrove forests have value as a tourism resource. On other islands, for example, Yakushima Island (Kagoshima Prefecture), Ishigaki Island (Okinawa Island) and Iriomote Island (Okinawa Island), the mangrove forests are now managed as an important tourism resource. The conservation of mangrove forests is to be considered not only from the scientific view point, but also from the tourism view point. In this respect, the planting of mangrove forests is notable. The creation of mangrove forests on Miyako Island began in 1992 (Note 5). On April 18, 1992, 5,000 mangrove seedlings were planted in Hirara City by the members of the local retired people's club as a service to the public. The total planted area was 0.4ha, and this was the first step in the planting of mangroves over a large area of Miyako Island (*Miyako Shinpo*, April 19, 1992). On August 20, 1993, 1,100 mangrove seedlings were planted at Shimoji Town by individuals and groups such as environmental groups, the women's society, and boy's environmental club. This planting activity was sponsored by the Shimoji Town Office (*Miyako Mainichi Newspaper*, August 21, 1993). These kinds of activities are an example of eco-tourism, but their existence is probably not known outside this island.

Policy Recommendation

1. Improvement of regional forest planning system

The forest planning system in Japan was introduced in the Forest Law of 1951, and the present planning system is regulated according to the revised Forest Law of 1991. The forest planning system was introduced the Ryukyu Islands after their return to Japan from the United States.

Miyako Island is a part of the Miyako and Yaeyama regional forest planning area. Each of the three main islands of this planning area, Miyako Island (158km²), Ishigaki Island (222 km²) and Iriomote Island (289km²), requires a separate forest plan. This is common feature of forest planning systems for all islands, especially in this planning area, and the different forest conditions on the Miyako and Yaeyama Islands must be considered. While Miyako Island is flat with low ratio of forested land, Ishigaki Island and Iriomote Island are mountainous and well forested. The regional forest plan for this area includes several overall forest statistics obtained by summing the data for these different islands. It is needless to say that these statistics do not express the actual situation.

The current regional forest plan does not even contain any data regarding the rate of decrease of forest area on each island. In the case of Miyako Island, the drastic change of forest area described in this paper has not been addressed in the current or previous forest plans, in spite of the increased concern regarding this issue. The regional forest plan should include several indices for each island.

2. Necessity for island use planning

As an island is a limited space, the land must be used effectively. Sections of municipal offices and prefectural governments have recently created various kinds of development plans independently of each other. In regional forest plans, the total forest area is projected to remain almost constant in the future because other developmental projects are not considered. Treeless land, for example, will be treated as a planting site in the forest plan, as an improvement site in the agricultural farm construction plan, and as a sports field in the public works plan. Recently, almost no forests on Miyako Island were targeted only for timber production, and accordingly the value of forest land was not appraised as highly as that of farm land. Forests on Miyako Island are frequently sites for various kinds of development works; as a result, the ratio of forested land has been decreasing. Furthermore, as no regulation of the total forest area of each island is provided by the forest planning systems, this pattern will not change.

In island areas, especially on a flat island like Miyako Island, a total island use plan is necessary for effective land use and conservation of non-timber resources, such as windbreak, headwater conservation, and recreation forests. Extensive public investment has frequently been introduced in island area of Japan as part of the development policy of the local economy. While most public facilities are necessary for island areas, their development should be coordinated. Various development projects may be carried out in a single forest, and the overall forest plan should therefore be regarded as important, and a coordinated island use planning agency should be considered.

Miyako Island is subdivided into 4 municipalities, each with its own administrative area. Most administrative plans are developed by the prefectural government or municipal bodies, and the duplicate formulation of plans may be ineffective or lead to overdevelopment. The many resort development plans for Miyako Island illustrate this point. The allocation of the protected forests must be discussed at all levels. In the formulation of an effective island use plan, the cooperation of all the municipal bodies concerned is the first prerequisite.

3. Forest investment planning

The purpose of forest investment is generally to increase timber production or productivity. The non-timber uses of forests have recently been recognized by the public, but the relation of these uses to non-timber-based industries, especially agriculture and tourism, has not been well recognized by investors.

In the farm development projects on Miyako Island, a partial windbreak forest will be created. However, the regulated minimum width of a windbreak forest is 6m, while minimum width that is effective in agriculture is thought to be 10m or more. These forests should be thought of as an investment in agriculture. This expansion will be realized only by a change in subsidy regulation.

Investment in forests is considered as a contribution to tourism. For example, the windbreak forest of a coastline with a sandy beach can be thought of as a recreational forest. Camping sites, orienteering courses, educational forests and various kinds of recreational forest

facilities have to be planned with consideration of the environmental aspects. Recreational facilities for older people or health-seeking tourists are lacking on this island, and this is related to the investment in forests. In addition, because Miyako Island is well known for sports, the investment in forests is a sports promotion activity. Traditionally, the investment in forests in Japan has been limited to timber production and to the creation of protected forests, but the goals of investment are changing due to the increase in recreational demand. Furthermore, a new type of forestry for tourism should be attempted on this island.

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Notes

- 1) Forest protection has been recommended for: headwater conservation, soil loss prevention, crumbling soil control, shifting sand control, windbreak, flood control, tide water control, drought disaster control, fog prevention, snow-slip prevention, stone-fall prevention, firebreak breeding, fish breeding, navigation targets, recreation, and scenic beauty.
- 2) Thirty years for *Pinus lutchuensis*, 40 years for *Podocarpus macrophyllus*, 25 years for *Casuarina equisetifolia*, and 30 years for broad-leaved trees.
- 3) A citizens' campaign for planting has started in Hirara. The object is to create green landscape by planting *Pinus lutchuensis* along the road and the vacant land owned by communities. The Department of Agriculture and Forestry of Hirara municipal office plans to distribute 20,000 seedlings to Hirara citizens during the period 1992-1996 (*Miyako Shinpo*, June 26, 1992).
- 4) The report on environmental assessment of Ouno Forests pointed out the following reasons for the recommendation of road construction: loss of scientific values, change of microclimate conditions among the forest, decreased importance for birds, increasing recreational activities (*Miyako Mainichi Newspaper*, April 24, 1991). After completing this report, the Hirara municipal office decided to change the policy on road construction (*Miyako Shinpo*, April 25, 1991).
- 5) Planting area by these recent movements is not counted in planting statistics in Table 6.

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* The title is tentatively translated from the original Japanese title to the English title by the author.